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NEW ENGLAND NOTE

AN UNUSUAL POPULATION OF *PODOSTEMUM CERATOPHYLLUM* (PODOSTEMACEAE) IN A TIDAL CONNECTICUT RIVER

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Podostemum ceratophyllum Michx. (riverweed, threadfoot) is unique ecologically and the only temperate North American species in the overwhelmingly tropical Podostemaceae. Distributed from Nova Scotia south to Arkansas and Louisiana with disjunct populations in Honduras and the Dominican Republic (Philbrick and Crow 1983), *P. ceratophyllum* occurs sparsely in the northern extent of its range. It appears on rare and endangered plant lists in all New England states except New Hampshire (Crow et al. 1981). In Connecticut, *P. ceratophyllum* has been collected from approximately 25 locations, but a number of historical populations have not persisted, including a Killingworth (Middlesex Co.) site that represented the first collection in New England.

On July 20, 2000, while surveying submerged angiosperms in tidal wetlands in the lower Connecticut River drainage, a new population of *Podostemum ceratophyllum* was found in Eight-Mile River in the town of Lyme, Connecticut. Subsequent investigation during August and early September showed that the bright green plants covered the rocks on the bottom of the river almost without interruption for a distance of more than 50 m, creating a patch of plants with a maximum width of 7 m. Upstream and downstream from this area, *P. ceratophyllum* grew abundantly over a total distance of approximately 100 m. The species occurred in scattered patches for a distance of 1.5 km upstream from this population, growing abundantly in several small areas of rapids or rapidly flowing water.

The area where *Podostemum ceratophyllum* grew most luxuriantly was freshwater, though subject to tidal fluctuation that greatly affected water depth and the strength of the current. Water depth through the area of dense growth was 10–30 cm at low tide on August 24, 2000. Current throughout this area was mea-

sured at 3.8–4.2 feet per second (fps) using a Global Water Flow Probe (Global Water Instrumentation, Gold River, CA). Plants at the downstream end of the population were under approximately 140 cm of water at high tide, and those at the upstream end were under 80–90 cm of water. Current at high tide dropped to 0.1–0.4 fps. Flow in the river declined during the next week, and current at low tide was recorded on August 31, 2000, at 1.9–3.4 fps in the area of luxuriant growth. No current was detectable at high tide. Other conditions also varied somewhat as a result of tidal influence. In the area of luxuriant growth, temperature increased from 21.4°C to 24.9°C between low tide and high tide on August 31, and turbidity declined from 2.2 to 0.8 Nephelometric Turbidity Units (NTUs).

Riverweed did not occur in upstream areas where current of less than 2.8 fps was recorded on August 24, 2000. The species occurred most abundantly in areas with current of 3.5–4.1 fps. Other conditions varied little between areas where *Podostemum ceratophyllum* grew profusely and where it occurred only sparsely or not at all (conductivity of 70–80 μS, pH of 6.8–6.9, temperature of 19.2–19.4°C, turbidity of 1.6–1.8 NTUs). The rocky substrate appeared uniformly suitable, and significant variation in light availability was not immediately apparent: tall trees grew along both sides of the river, and no part of the riverbed received full sun throughout the day. Salinity was not measured but is not believed to be a factor in this area. In 1994, the Nature Conservancy tested for salinity downstream from this population in Hamburg Cove, which is a 3.5 km-long cove on the Connecticut River, 11.5 km north of Long Island Sound. Water within 800 m of this population was found to be free of salinity, and salinity at the nearest location where it was recorded was measured at only 2‰ (Barrett et al. 1997).

Podostemum ceratophyllum usually is associated with rapids and waterfalls, but our observations indicate that the species can grow luxuriantly in swiftly flowing water even if it is not particularly turbulent. Further, intermittent rapid flow apparently is adequate to support a large, healthy population of riverweed. Plants in the Eight-Mile River population grew luxuriantly where rapid flow occurred only during low water and where there was no current at high water. Plants were less vigorous in upstream areas beyond the reach of tidal flooding, where the current had an invariant but intermediate rate. This observation indicates that there

is a threshold water current value (perhaps near 2.8 fps) below which *P. ceratophyllum* does not occur in the river.

Tidal flux also affects flowering of the plants. Riverweed flowers only when water level drops and plants are exposed to the air (Philbrick and Crow 1992). Few plants in the Eight-Mile River population were observed in flower during August and September, 2000. Flowering plants occurred only along the margins of the river and on boulders in mid-stream that were exposed at low tide. This indicates that permanent exposure is not necessary to induce flowering in riverweed at this site. Summer rainfall was greater than usual in Connecticut, and a larger proportion of this population may flower during drier summers.

The size of this population indicates that it is neither new nor ephemeral. *Podostemum ceratophyllum* has been known to exist in Devil's Hopyard State Park (10 km upstream on the Eight-Mile River) since 1933 and was confirmed to persist on scattered rocks in rapids at that location in August, 2000. The Devil's Hopyard plants are the likely source of propagules that have colonized the river downstream. The Eight-Mile River populations are the only ones known from the Connecticut River drainage basin in Connecticut. Throughout New England, the species is known from two locations on the Connecticut River itself and from seven other tributaries—four in Massachusetts and one in Vermont, (C. T. Philbrick, pers. comm.).

Existence of this large, healthy population on the Eight-Mile River is reassuring from a conservation standpoint. Intrapopulation genetic variation among *Podostemum ceratophyllum* in the glaciated Northeast is virtually non-existent (Philbrick and Crow 1992), so each population represents an important component of the species' total genetic variability, and identification and protection of new populations becomes particularly important. However, these observations also show that there is much yet to be learned about riverweed ecology. Although the species is known to be vulnerable to chemical pollution, sedimentation, and changes in water flow (Philbrick and Crow 1983), very little ecological study of its environmental characteristics has been done (Quiroz F. et al. 1997). *Podostemum ceratophyllum* has not previously been reported from tidal waters, although a Brazilian species of *Podostemum* also is known to occur in areas that are tidally influenced (C. T. Philbrick, pers. comm.). Improved understanding of the species' ecology has importance outside the realm of bot-

any. Riverweed is the dominant macrophyte in some streams, providing structure for the invertebrate community (Everitt and Burkholder 1991). It also is an indicator species for habitat critical for the survival of several federally endangered species including the amber darter (*Percina antesella*) and the Conasauga logperch (*Percina jenkinsi*; U.S. Fish and Wildlife Service 1985). The discovery of this large population of riverweed in an area where it would not previously have been expected indicates that it may be fruitful to seek other new populations in similar, tidally influenced areas.

Podostemum ceratophyllum Michx. Connecticut: New London Co., Lyme, Eight-Mile River, N side of Joshuatown Rd. 40 m E of Old Hamburg Rd. and 240 m W of Rte 156, 20 Jul 2000, *Capers 234* (CONN); 31 Jul 2000, *Capers 235 & Les 671* (CONN).

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